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THEORETICAL IN SITU STRATA RESERVOIR AND PORE PRESSURE CALCULATIONS FOR MATERIAL FROM NO. 26 COLLIERY, N.S.

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THEORETICAL IN SITU STRATA RESERVOIR AND PORE PRESSURE CALCULATIONS FOR MATERIAL FROM NO. 26 COLLIERY, N.S.

by

T.R.C. Aston*

SUMMARY

Back analysis of existing field data was undertaken to calculate theoretical in situ strata reservoir pressures within an outburst prone sandstone unit at No. 26 Colliery, Sydney Coalfield. After a brief description of field and laboratory measurements, the application of the General Gas and Darcy's Law equations are described along with the Direct Ratio method.

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CALCUL THÉORIQUE IN SITU DES PRESSIONS DE RÉSERVOIR ET INTERSTITIELLE DES MATÉRIAUX DE LA HOUILLÈRE N°26 (N.-É.)

par

T.R.C. Aston*

RÉSUMÉ

On a fait des analyses à partir de données déjà recueillies sur le terrain, dans le but de calculer in situ, les pressions de réservoir à l'intérieur d'une zone de grès prédisposée au dégagement instantané de gaz, de la houillère N°26 du bassin houiller de Sydney. Ce rapport présente aussi une brève description des mesures prises sur le terrain et en laboratoire, de l'application des équations de la dynamique des gaz et de la loi de Darcy ainsi que la méthode de raison directe.

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NOMENCLATURE

ρ_r - Density of rock

M_r - Mass of rock ejected by outburst

V_r - Volume of rock ejected by outburst

M_s - Mass of sample

V_s - Volume of gas released by sample

V_o - Theoretical volume of gas released by outburst

y_i - Mole fraction of component i in gas mixture

M_i - Molecular weight of component i

M_g - Molecular weight of gas

M_a - Molecular weight of air

P_{pc} - Pseudocritical pressure

T_{pc} - Pseudocritical temperature

z - Compressibility factor

p - Pressure

V_{rs} - Volume of reservoir

$\emptyset$ - Porosity

S_w - Water saturation

P_b - Base pressure for gas measurement

G - Volume of gas at standard conditions

Z_b - Base compressibility factor

T_b - Base temperature for gas measurement

V - Volume holding gas in reservoir

T - Absolute temperature

q - Flow

k - Permeability

h - Thickness/length of test section

P_e - Pressure at external radius, r_e (reservoir)

P_w - Pressure at internal radius, r_w (test section)

μ - Average viscosity

T_f - Flowing temperature

r - Radius

P_{pr} - Pseudoreduced pressure

T_{pr} - Pseudoreduced temperature

NOTE: The General Gas and Darcy equations given by Smith (4) were derived for use with imperial units. All metric data obtained during the No. 26 outburst study was therefore converted to imperial units in order to simplify the use of these equations.

INTRODUCTION

Since 1977, 37 events identified as outbursts have occurred in the No. 26 Colliery workings below a depth of 700 m. In general, the early events were described as roof falls because of their docile nature and because no methane emission was recorded. However, the two most recent events, in November 1983 and January 1984 were particularly violent and resulted in the temporary cessation of further 'main deeps' development until a method of control could be implemented.

The November 24, 1983 event occurred immediately after shotfiring and destroyed 16 m of roadway, ejected 300 m^3 of rock and liberated 750 m^3 of methane. After refurbishing the roadway, a second outburst occurred on January 6, 1984 when coal ribs were bored and fired to trim the entry profile at the face prior to back filling the first cavity with foamed cement. The second outburst destroyed 14 m of resupported roadway, ejected 150 m^3 of rock, principally sandstone and almost 3200 m^3 of methane.

This report after an initial outline of work undertaken to measure the in situ strata gas pore pressure and gas content of the outburst material, describes a series of calculations made to determine the theoretical in situ reservoir and pore pressure of the No. 26 outburst prone sandstone.

IN SITU STRATA GAS PRESSURE MEASUREMENT

The in situ gas pressure of the outburst prone sandstone unit was measured using a double packer arrangement (1), installed in a borehole drilled parallel to the 'main deeps' in the vicinity of the outburst area. The packer was installed in a sandstone unit exhibiting core discing and left to equalise with the in situ strata pressure. After five days, no discernable increase in pressure had occurred, so the test cavity was pressurized with nitrogen in order to stimulate gas flow from the surrounding strata. A plot of the resultant test cavity pressure against time is given in Figure 1.

The equilibrium pressure of 2.8 MPa obtained in the test cavity may be indicative of the in situ strata pressure of the sandstone, although it is probably more representative of steady state conditions, whereby the volume

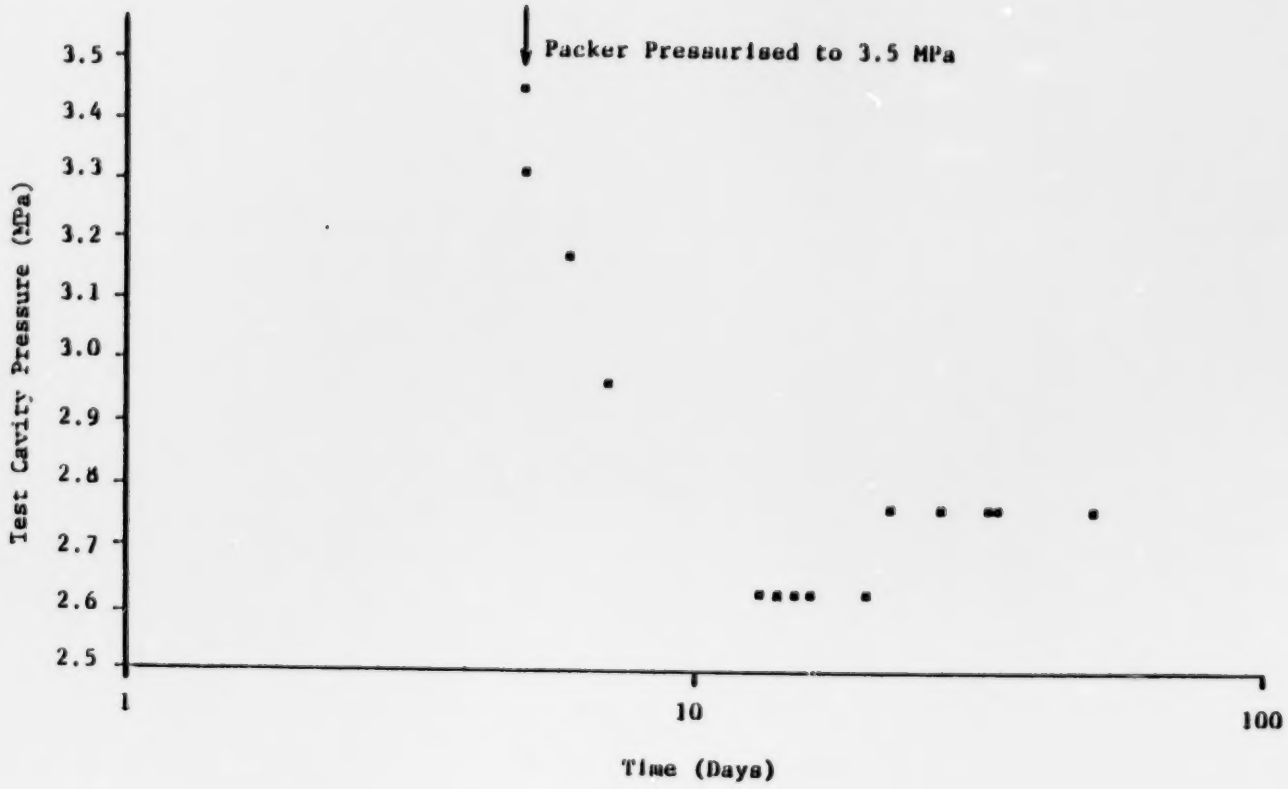

Figure 1 - Test cavity pressure against time, No. 26 Colliery borehole

of gas lost by leakage around the packer equals the volume of gas yielded by the strata.

GAS CONTENT DETERMINATIONS OF THE SANDSTONE

Total gas content was determined for a number of sandstone samples from the immediate area of the 'main deeps' outbursts (2,3). Samples of intact core and outburst material were ground to minus 2 mm in a sealed ball mill containing an inert nitrogen atmosphere.

Table 1 summarizes the sample weights and liberated gas volumes from these measurements.

Table 1 - Sample weights and liberated gas volumes, outburst prone area, No. 26 Colliery

Sandstone Description	Sample Weight (g)	Total Gas Release (cc)
1. Ejected Material	1390	426
2. Ejected Material*	5886	351
3. Intact Core	1083	160
4. Intact Core	1714	259

* Sample diluted with siltstone/mudstone material.

DIRECT RATIO METHOD

Using the volume of gas release by the sample, Table 1, it is possible to calculate a theoretical volume of gas released by the outburst material ejected during the November 1983 and January 1984 events.

If,

$$\rho_r = \frac{M_r}{V_r} \quad \text{(see nomenclature list)} \qquad \text{Eq 1}$$

then, $$M_r = V_r \times \rho_r \quad \text{Eq 2}$$

If Sample 1 (M_s) released V_s cc of gas, the theoretical volume of gas (V_o) released by the outburst event will be:

$$V_o = \frac{M_r}{M_s} \times \frac{V_s}{10^6} \ m^3 \quad \text{Eq 3}$$

Table 2 gives the range of gas volumes which should theoretically have been released by the November 1983 and January 1984 events. In each case the rock density (ρ_r) was taken as 2600 kg/m^3 and the volume of ejected material (V_r) 300 m^3 and 150 m^3 respectively.

Table 2 - Direct ratio method, theoretical gas volumes released by the No. 26 Colliery outburst events

Sample Description	Outburst 1 (November 1983)	Outburst 2 (January 1984)
Volume of Ejected Material m^3	300	150
Actual Volume of Gas Released m^3	750	3200
Theoretical Volume of Gas Released (Sample 1) m^3	252	120
Theoretical Volume of Gas Released (Sample 2) m^3	49	23
Theoretical Volume of Gas Released (Sample 3) m^3	121	57
Theoretical Volume of Gas Released (Sample 4) m^3	124	59

GENERAL GAS EQUATION

Derivation of the General Gas equation is considered beyond the scope of this report and is given elsewhere (4).

A gas mixture will behave as if its molecular weight is the same as a pure gas. The weight of 1 mole of the gas mixture and its molecular weight will therefore be:

$$\text{Average Molecular Weight} = \sum (y_i \times M_i) \qquad \text{Eq 4}$$

In the case of the gas sample collected from the No. 26 test cavity, Table 3 :

Table 3 - Analysis of gas sample collected from No. 26 Colliery test cavity

Gas Constituent	Gas Concentration
Nitrogen N_2	92.52%
Methane CH_4	6.5%
Oxygen O_2	0.98%
Carbon Monoxide CO	8 ppm

Gas Component	Weight Fraction	Molecular Weight	Moles/lb.
N_2	.9252	28.013	.03303
CH_4	.0650	16.043	.00405
O_2	.0098	32.000	.00306
CO	.000008	28.000	.0000003
	1.000000		0.04014

Hence,

$$\text{Molecular Weight of No. 26 Gas} = \frac{\text{Weight}}{\text{Moles}} = \frac{1.000}{0.04014} = 24.913 \qquad \text{Eq 5}$$

$$\text{Specific Gravity } \gamma_g = \frac{M_g}{M_a} = \frac{24.913}{28.964} = 0.86 \qquad \text{Eq 6}$$

From Appendix A,

$$P_{pc} = 664 \text{ psia}$$

$$T_{pc} = 444°F \text{ (absolute)}$$

If one assumes that the pressure of the gas in the sandstone unit was 400 psia at a virgin rock temperature of 70°F, then the compressability factor of the gas (z) can be calculated as follows (4):

At, p = 400 psia and 70°F

P_{pr} = 400/664 = 0.602

T_{pr} = (70 + 460)/444 = 1.193

From Appendix B, z = 0.872

The compressability of (Z_b) the gas once liberated to the mine workings (15 psia and 70°F) was assumed to be 1.00.

If the volume holding the gas in the reservoir is assumed to be either the outburst material, events 1 and 2, or samples 1 and 2:

$$V = V_{rs}(\emptyset)(1- S_w) \qquad \text{Eq 7}$$

where V is the volume of gas contained within the reservoir at 400 psia and 70°F.

It is now possible to use a modified form of the General Gas equation (4):

$$\frac{P_b G}{Z_b T_b} = \frac{pV}{zT} \qquad \text{Eq 8}$$

where G is the volume at 15 psia and 70°F or the volume of gas liberated during the outburst or by the gas content determination.

OUTBURST EVENTS 1 AND 2

1) Event 1 - Vol. of Ejected Material = 300 m^3
- Porosity = 5%
- Water Saturation (Assumed) = 2%

Convert - 300 m^3 to cubic feet (ft^3)

300 x 35.314 = 10594 ft^3

Vol. Holding Gas in Reservoir: $V = V_{rs}(\emptyset)(1 - S_w)$ Eq 7

$= 10594 \times 0.05 \times 0.98$

$= 519\ ft^3$

Substitute values into $\frac{P_b G}{Z_b T_b} = \frac{pV}{zT}$ Eq 8

where $G = 26500\ ft^3$ (gas liberated by outburst event 1)

$$\frac{15(26500)}{1.00(530)} = \frac{p(519)}{0.87(530)}$$

$$p = \frac{15(26500) \times 0.87 \times 530}{519 \times 1.00 \times 530} = 666 \text{ psi}$$

2) Event 2

A similar calculation gives a pressure of 5671 psi.

GAS CONTENT SAMPLES 1 TO 4

If assumed, $1\ m^3$ of rock = 2600 kg

then, 1 kg of rock occupies $0.000385\ m^3$

Therefore:

Sample No	Sample Weight (kg)	Vol. of Sample m^3	Vol. of Sample ft^3	Vol. of Gas Released m^3	Vol. of Gas Released ft^3
1	1.390	0.000535	0.0190	426×10^{-6}	0.0150
2	5.866	0.00226	0.0798	351×10^{-6}	0.0124
3	1.083	0.000417	0.0150	160×10^{-6}	0.00565
4	1.714	0.00066	0.0230	259×10^{-6}	0.00915

In case of Sample 1,

Vol. of Sample = $0.019\ ft^3$

$\emptyset = 5\%$

$S_w = 2\%$

Volume Holding Gas = $0.019 \times 0.05 \times 0.98 = 0.000925$ Eq 7

Substitute values into modified gas equation: $\frac{P_b G}{Z_b T_b} = \frac{pV}{zT}$ Eq 8

$$\frac{15 \times 0.015}{1.00 \times 530} = \frac{p \times 9.25 \times 10^{-4}}{0.87 \times 530}$$

$$p = \frac{15 \times 0.015 \times 0.87 \times 530}{9.25 \times 10^{-4} \times 1.00 \times 530} = 211.62 \text{ psi } (1.46 \text{ MPa})$$

From the total gas release values given in Table 1, it is possible to calculate an inferred porosity for the sample at STP:

Sample 1,

$$\text{Vol. of Sample} = \frac{M_s}{\rho_r} = \frac{1390}{2.6} = 535 \text{ cc} \quad \text{Eq 9}$$

Vol. of Gas Released = 426 cc

Substitue into $V = V_r (\emptyset)(1 - S_w)$ Eq 7

$$426 = 535 \times \emptyset \times 0.098$$

$$\emptyset = \frac{426}{524.3} = 0.81\%$$

Calculated internal pore pressures and inferred porosites at STP for Samples 1 to 4 are given in Table 4.

Table 4 - Calculated internal pore pressures and inferred porosity, outburst prone area, No. 26 Colliery

Sample Number	Calculated Internal Pore Pressure (MPa)	Inferred Porosity at STP (%)
1	1.46	81
2	0.28	16
3	0.70	39
4	0.72	40

DARCY'S LAW

Derivation of Darcy's Law for the radial flow of gas through a porous media is considered beyond the scope of the report and is given elsewhere(4).

Volume of gas in the packer test section would be 4.42 litres at 15 psi (STP) and 8.84 litres at 30 psi, hence change of 0.295 litres per 1 psi change. Using the pressure change shown in Figure 1:

At 380 psi + 15 psi = 295 psi = 116.525 litres
At 400 psi + 15 psi = 415 psi = 122.424 litres

Hence, increase in volume is 3 litre (0.106 ft^3) per day for 10 psi/day increase in pressure.

By using the Darcy equation for the radial flow of gas in a porous media (4):

$$q = \frac{307.4\ kh(P_e^{\ 2} - P_w^{\ 2})}{\mu z\ T_f\ \log\ r_e/r_w} \qquad \text{Eq 10}$$

where

$q = 0.106$
$k = 0.05$ or 0.0005 md
$P_w = 400$ psi
$\mu = 0.02$ cp
$z = 0.87$
$r_e = 60$ ft
$r_w = 0.12$ ft
$T_f = 530°F$
$h = 3.28$ ft

Hence, $$0.106 = \frac{307.4 \times 0.05 \times 3.28\ (p_e^{\ 2} - 400^2)}{0.87 \times 0.02 \times 530 \times \log\ 60/0.12}$$

where $p_e = 400.065$ psi

Solving the equation with a permeability of 0.0005 md gives an in situ strata pressure (P_e) of 406.5 psi.

DISCUSSION

Simple proximate analysis of the outburst prone sandstone revealed a carbon content of between 1.4 and 2.4%, Table 5. If these values are used to calculate a theoretical volume of methane desorpted from the outburst material, it is possible to determine whether the methane quantities recorded could have originated from this source.

Table 5 - Proximate analysis results from the outburst prone sandstone unit, No. 26 Colliery

Material Type	% Carbon	% Inorganic Carbon	% Carbonate
Disced Sandstone	1.40	1.60	
Outburst Material	2.11	1.28	Range 2.5 to 3.5
Borehole Sandstone	2.40	1.03	
	1.97	0.96	

Assuming a carbon content of 60% in the No. 26 Harbour seam coal (5) and a desorption of 9 m^3/tonne of methane, the additional quantities of methane released would vary between 60 - 110 m^3 for Event 1 and 30 - 55 m^3 for Event 2. If the amount of desorpted gas is increased to 25 m^3/tonne, the additional quantities of methane released increase to between 170 - 300 m^3 for Event 1 and 85 - 150 m^3 for Event 2. Methane released by desorption from carbonaceous material contained within the outburst prone sandstone still cannot account for the total volume of methane released by the outburst events.

In order to obtain the necessary volume of methane released, the amount of carbonaceous material contained within the sandstone would have to be 6% for Event 1 and 51% for Event 2.

Agreement between the Darcy's law results and the packer experiments may be coincidental, although it should be noted that the values are similar to those obtained from the in situ monitoring of various coal seams around the world (6) and these values fall in the range 3.1 to 4.2 MPa. This pressure therefore represents the establishment of an equilibrium between the gas phase and the methane absorbed onto the coal material. It is therefore not surprising that during geological time, a sandstone sandwiched between coal seams will reach the equilibrium pressure of the seams.

Analysis of the No. 26 Colliery data has shown that several theoretical techniques can be used for the back analysis of in situ reservoir pressure within an outburst prone unit. However, it is important to realise that any values obtained by these techniques will only be as good as the input data. It is therefore essential that any ongoing outburst research programme establishes a comprehensive data base of strata and reservoir properties and that a high degree of confidence can be placed in these values.

CONCLUSION

Porosity and permeability measurements undertaken on the ejected sandstone material cannot be used to account for the quantity of gas released by the outburst events and the concept of an elevated gas pressure within the sandstone horizon was therefore developed. Field measurements suggest an in situ strata pressure of 2.8 MPa, while back analysis of the available data using the General Gas and Darcy equations gives a range of in situ pressures between 0.28 and 40 MPa.

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APPENDIX A

PSEUDOCRITICAL PROPERTIES OF HYDROCARBON GASES P_{pc} AND T_{pc} [after Smith (4)]

be at a pressure of 30 in. of mercury at 32°F and a temperature of 60°F. The only safe way through the thicket of definitions is through the sales contract.

Point of delivery. One of the most important pieces of information for the field engineer is the point of delivery because the seller is usually responsible for the equipment up to that point. The title to the gas passes from the seller to the buyer at the point of delivery. Also, the contract may state that the seller shall deliver gas at the varying pressures maintained at the delivery point, which means that the seller must furnish the compression facilities that may be necessary to deliver the gas.

Gas measurement. The gas measurement section of the contract usually states that the orifice meters shall be installed, operated, and gas volumes computed in accordance with the recommendations prescribed in "*Orifice Metering of Natural Gas.*" Gas Measurement Committee Report No. 3 dated April 1955 of the American Gas Association or such subsequent changes as are mutually agreed upon. The contract may specify the barometric pressure to be used in calculating absolute pressures and may adopt constant values for the Reynolds number factor, F_r, the expansion factor, Y, the supercompressibility factor, F_{pv}, and the manometer factor, F_m (see equation 4–5). Other factors may be specified unless they are measured.

Also, the gas measurement provisions may set specific times for calibrating the meter, checking the orifice plate, measuring specific gravity, determining heating value and setting procedures for adjusting errors in gas measurement. All of these are important considerations for the seller.

SUMMARY

The sale of natural gas differs from that of crude oil in several ways. Gas cannot be stored on the lease except by leaving it unproduced. Therefore, the seller must have his wells ready to produce when there is a market for the gas. The price paid for gas is subject to complicated regulation at present writing, and the price may vary from well to well even though the wells are in the same reservoir. As a result, the engineer involved in the management and operation of gas wells must have a working knowledge of the sales contracts that govern the sale of the gas. The pertinent features of the contracts that influence engineering decisions have been identified.

APPENDIX A. Compressibility Factors for Natural Gas

TABLE A–1.

*Pseudocritical Properties of Hydrocarbon Gases, p_{pc} and T_{pc} **

γ_g	p_{pc}	T_{pc}	γ_g	p_{pc}	T_{pc}
0.55	673	336	0.85	664	441
0.56	673	341	0.86	664	444
0.57	672	346	0.87	663	448
0.58	672	350	0.88	663	451
0.59	672	354	0.89	662	454
0.60	671	358	0.90	662	457
0.61	671	362	0.91	662	461
0.62	671	365	0.92	662	464
0.63	670	368	0.93	661	467
0.64	670	372	0.94	661	471
0.65	670	375	0.95	660	474
0.66	670	378	0.96	660	477
0.67	669	382	0.97	659	481
0.68	669	385	0.98	659	484
0.69	669	388	0.99	659	487
0.70	668	392	1.00	658	491
0.71	668	395	1.01	658	494
0.72	668	398	1.02	657	497
0.73	668	401	1.03	658	500
0.74	667	405	1.04	656	504
0.75	667	408	1.05	655	507
0.76	667	411	1.06	656	510
0.77	666	415	1.07	654	514
0.78	666	418	1.08	654	517
0.79	666	421	1.09	653	520
0.80	665	424	1.10	652	524
0.81	665	428	1.11	652	527
0.82	665	431	1.12	651	530
0.83	665	434	1.13	651	534
0.84	664	438	1.14	650	537

Do not interpolate, values are inclusive to the next higher value.

* Used by permission of the Pacific Energy Association (formerly the California Natural Gasoline Association), taken from Bulletin No. TS–461, 1947. Data are for the average of the natural gas mixtures occuring in the western states—primarily California.

APPENDIX B

COMPRESSIBILITY FACTORS FOR NATURAL GASES AT VARIOUS PSEUDOREDUCED PRESSURES, P_{pr} AND PSEUDOREDUCED TEMPERATURES, T_{pr} [after Smith (4)]

TABLE A–2.
*Corrections for Pseudocritical Properties of Hydrocarbon Gases for Carbon Dioxide, Nitrogen, and Hydrogen Sulfide**

Add if positive or subtract if negative from values in table A–1.

Volume Percent of CO_2 or N_2 in Gas	Carbon Dioxide, CO_2		Nitrogen, N_2		Hydrogen sulfide, H_2S	
	P_{pc}	T_{pc}	P_{pc}	T_{pc}	P_{pc}	T_{pc}
1	+ 4	− 1	− 1	− 3	+ 2	−2
2	+ 8	− 3	− 3	− 6	+ 4	−2
3	+ 12	− 5	− 5	− 9	+ 7	−3
4	+ 17	− 7	− 7	−11	+10	−3
5	+ 21	− 9	− 9	−14	+15	−4
6	+ 25	−11	−11	−17		
7	+ 30	−12	−12	−20		
8	+ 34	−14	−14	−22		
9	+ 38	−16	−16	−25		
10	+ 44	−17	−17	−28		
11	+ 48	−19	−19	−30		
12	+ 53	−21	−21	−33		
13	+ 57	−22	−22	−36		
14	+ 61	−24	−24	−39		
15	+ 66	−26	−26	−42		
16	+ 70	−27	−27	−44		
17	+ 74	−29	−29	−47		
18	+ 79	−31	−31	−50		
19	+ 83	−32	−32	−52		
20	+ 87	−34	−34	−55		
21	+ 92	−36	−36	−58		
22	+ 96	−37	−37	−60		
23	+100	−39	−39	−63		
24	+104	−41	−41	−66		
25	+109	−42	−42	−68		
26	+113	−44	−44	−71		
27	+117	−46	−46	−74		
28	+122	−47	−47	−77		
29	+126	−49	−49	−79		
30	+130	−51	−51	−82		
31	+134	−52	−52	−85		
32	+139	−54	−54	−87		
33	+143	−56	−56	−90		
34	+147	−57	−57	−93		
35	+152	−59	−59	−95		
36	+156	−61	−61	−98		

* Values for carbon dioxide and nitrogen are based on data from the California Natural Gasoline Association Bulletin No. 73–48B. Used by permission of the Interstate Oil Compact Commission. Values for hydrogen sulfide are supplied by the author.

TABLE A–3.
*Compressibility Factors for Natural Gases at various Pseudoreduced Pressures, P_{pr}, and Pseudoreduced Temperatures, T_{pr}.**

Pseudo-reduced Pressure, P_{pr}	Pseudoreduced Temperature, T_{pr}									
	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
0.20	0.928	0.948	0.963	0.959	0.964	0.968	0.971	0.973	0.976	0.979
0.25	0.922	0.934	0.941	0.949	0.955	0.960	0.964	0.968	0.972	0.974
0.30	0.906	0.920	0.928	0.938	0.946	0.951	0.956	0.962	0.965	0.968
0.35	0.887	0.905	0.914	0.927	0.937	0.943	0.949	0.956	0.960	0.964
0.40	0.868	0.889	0.900	0.916	0.928	0.934	0.942	0.949	0.953	0.959
0.45	0.849	0.872	0.887	0.905	0.919	0.926	0.934	0.943	0.948	0.954
0.50	0.829	0.855	0.874	0.894	0.910	0.918	0.926	0.937	0.942	0.949
0.55	0.810	0.839	0.862	0.883	0.900	0.908	0.919	0.930	0.937	0.944
0.60	0.790	0.822	0.849	0.872	0.890	0.900	0.912	0.923	0.931	0.939
0.65	0.769	0.804	0.835	0.861	0.881	0.893	0.905	0.917	0.926	0.935
0.70	0.747	0.785	0.820	0.850	0.871	0.885	0.898	0.911	0.921	0.930
0.75	0.722	0.767	0.806	0.839	0.861	0.876	0.890	0.905	0.916	0.925
0.80	0.698	0.748	0.791	0.827	0.851	0.870	0.883	0.899	0.910	0.920
0.85	0.672	0.729	0.776	0.815	0.842	0.861	0.876	0.893	0.905	0.916
0.90	0.645	0.710	0.761	0.802	0.832	0.852	0.870	0.887	0.899	0.911

* Table A–3 in its entirety was taken from P H Poettmann and P G Carpenter, "The Multiphase Flow of Gas, Oil, and Water through Vertical Flow Strings with Application to the Design of Gas Lift Installations," *API Drilling and Production Practice*, pp 279 91 (1952). Use herein was granted by permission of the American Petroleum Institute

Table A–3, continued

Pseudoreduced Pressure, P_{pr}	Pseudoreduced Temperature, T_{pr}									
	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
0.95	0.618	0.690	0.748	0.791	0.823	0.845	0.863	0.881	0.895	0.906
1.00	0.590	0.670	0.734	0.780	0.813	0.838	0.856	0.876	0.890	0.901
1.05	0.566	0.647	0.719	0.768	0.803	0.829	0.849	0.869	0.885	0.897
1.10	0.520	0.624	0.703	0.756	0.793	0.820	0.842	0.862	0.879	0.893
1.15	0.482	0.602	0.688	0.743	0.783	0.812	0.836	0.856	0.874	0.889
1.20	0.444	0.580	0.672	0.731	0.773	0.804	0.829	0.850	0.869	0.884
1.25	0.308	0.555	0.656	0.719	0.763	0.797	0.823	0.845	0.864	0.880
1.30	0.351	0.530	0.640	0.707	0.753	0.789	0.817	0.839	0.859	0.876
1.35	0.307	0.505	0.623	0.695	0.743	0.781	0.810	0.834	0.855	0.872
1.40	0.263	0.480	0.605	0.682	0.732	0.772	0.803	0.828	0.850	0.868
1.45	0.259	0.453	0.588	0.670	0.721	0.765	0.797	0.824	0.846	0.864
1.50	0.254	0.425	0.570	0.657	0.710	0.757	0.791	0.817	0.841	0.859
1.55	0.253	0.409	0.556	0.646	0.701	0.750	0.786	0.811	0.837	0.855
1.60	0.251	0.393	0.541	0.634	0.691	0.742	0.779	0.806	0.832	0.851
1.65	0.251	0.386	0.529	0.623	0.682	0.736	0.773	0.800	0.828	0.847
1.70	0.252	0.378	0.517	0.612	0.672	0.728	0.767	0.795	0.823	0.843
1.75	0.256	0.374	0.507	0.602	0.664	0.720	0.761	0.790	0.819	0.840

1.80	0.260	0.370	0.497	0.592	0.656	0.712	0.756	0.784	0.816	0.837
1.85	0.265	0.370	0.489	0.582	0.648	0.706	0.750	0.779	0.811	0.834
1.90	0.270	0.369	0.480	0.572	0.640	0.699	0.744	0.774	0.806	0.830
1.95	0.276	0.369	0.474	0.564	0.634	0.693	0.738	0.771	0.803	0.827
2.00	0.280	0.370	0.467	0.556	0.627	0.687	0.732	0.767	0.799	0.824
2.05	0.286	0.371	0.462	0.547	0.620	0.681	0.727	0.762	0.795	0.821
2.10	0.292	0.372	0.457	0.539	0.612	0.674	0.721	0.757	0.791	0.818
2.15	0.298	0.374	0.454	0.534	0.607	0.669	0.716	0.753	0.788	0.815
2.20	0.305	0.376	0.450	0.528	0.602	0.663	0.711	0.748	0.784	0.811
2.25	0.311	0.378	0.449	0.525	0.598	0.658	0.707	0.745	0.781	0.808
2.30	0.318	0.380	0.448	0.522	0.593	0.652	0.702	0.741	0.778	0.806
2.35	0.324	0.383	0.448	0.521	0.590	0.649	0.699	0.737	0.776	0.803
2.40	0.330	0.387	0.449	0.520	0.586	0.645	0.695	0.733	0.771	0.800
2.45	0.336	0.390	0.450	0.520	0.583	0.642	0.692	0.731	0.768	0.798
2.50	0.343	0.394	0.451	0.519	0.581	0.638	0.688	0.728	0.766	0.796
2.55	0.349	0.398	0.454	0.519	0.581	0.636	0.685	0.726	0.763	0.793
2.60	0.356	0.402	0.458	0.520	0.580	0.633	0.682	0.722	0.760	0.791
2.65	0.362	0.406	0.460	0.521	0.580	0.631	0.680	0.720	0.758	0.789
2.70	0.369	0.410	0.463	0.522	0.579	0.629	0.678	0.718	0.756	0.787
2.75	0.375	0.414	0.467	0.524	0.579	0.628	0.676	0.716	0.754	0.786
2.80	0.381	0.419	0.472	0.526	0.579	0.627	0.673	0.713	0.752	0.783
2.85	0.387	0.424	0.476	0.528	0.579	0.626	0.672	0.712	0.750	0.781
2.90	0.394	0.429	0.481	0.530	0.580	0.625	0.670	0.710	0.748	0.779

Table A-3, continued

Pseudo-reduced Pressure, P_{pr}	Pseudoreduced Temperature, T_{pr}									
	1 60	1 70	1 80	1 90	2 00	2 20	2 40	2 60	2 80	3 00
0 20	0 984	0 987	0 990	0 991	0 993	0 995	0 998	0 999	1 000	1 001
0 25	0 980	0 984	0 988	0 990	0 992	0 995	0 998	0 999	1 000	1 001
0 30	0 976	0 981	0 985	0 988	0 990	0 994	0 997	0 999	1 000	1 001
0 35	0 972	0 978	0 983	0 986	0 989	0 994	0 997	0 999	1 000	1 001
0 40	0 968	0 975	0 980	0 983	0 987	0 992	0 996	0 998	1 000	1 002
0 45	0 964	0 972	0 978	0 981	0 986	0 991	0 995	0 998	1 000	1 002
0 50	0 960	0 969	0 976	0 979	0 983	0 990	0 994	0 998	1 000	1 002
0 55	0 956	0 966	0 974	0 978	0 982	0 989	0 994	0 998	1 000	1 002
0 60	0 952	0 963	0 971	0 976	0 981	0 988	0 993	0 997	1 000	1 003
0 65	0 948	0 961	0 969	0 974	0 980	0 987	0 993	0 997	1 000	1 003
0 70	0 946	0 958	0 967	0 972	0 978	0 986	0 992	0 997	1 001	1 004
0 75	0 942	0 956	0 965	0 971	0 977	0 985	0 992	0 997	1 001	1 004
0 80	0 938	0 952	0 962	0 969	0 975	0 984	0 991	0 997	1 001	1 005
0 85	0 936	0 950	0 960	0 967	0 974	0 983	0 991	0 997	1 001	1 005
0 90	0 931	0 947	0 958	0 965	0 972	0 983	0 990	0 996	1 001	1 006
0 95	0 927	0 944	0 956	0 963	0 971	0 982	0 990	0 996	1 001	1 006
1 00	0 923	0 941	0 953	0 961	0 970	0 981	0 989	0 996	1 001	1 007
1 05	0 920	0 939	0 951	0 960	0 969	0 980	0 989	0 996	1 001	1 007
1 10	0 917	0 936	0 949	0 958	0 967	0 979	0 988	0 996	1 002	1 008
1 15	0 913	0 933	0 947	0 957	0 966	0 979	0 988	0 996	1 002	1 008
1 20	0 909	0 930	0 946	0 956	0 964	0 978	0 987	0 996	1 002	1 008
1 25	0 906	0 928	0 943	0 954	0 963	0 978	0 987	0 996	1 002	1 008
1 30	0 901	0 926	0 941	0 952	0 962	0 977	0 987	0 996	1 002	1 009
1 35	0 898	0 923	0 940	0 951	0 961	0 976	0 986	0 996	1 002	1 009
1 40	0 895	0 920	0 938	0 949	0 960	0 976	0 986	0 996	1 002	1 010
1 45	0 892	0 918	0 936	0 947	0 959	0 976	0 986	0 996	1 002	1 010
1 50	0 889	0 915	0 934	0 946	0 957	0 974	0 985	0 996	1 003	1 010
1 55	0 886	0 913	0 932	0 945	0 956	0 973	0 985	0 995	1 003	1 010
1 60	0 882	0 910	0 930	0 943	0 954	0 972	0 984	0 995	1 003	1 011
1 65	0 880	0 908	0 929	0 942	0 953	0 972	0 984	0 995	1 003	1 011
1 70	0 877	0 905	0 927	0 941	0 952	0 971	0 983	0 995	1 004	1 012
1 75	0 874	0 903	0 925	0 940	0 951	0 971	0 983	0 996	1 004	1 012
1 80	0 87.	0 900	0 923	0 938	0 950	0 970	0 983	0 995	1 004	1 012
1 85	0 869	0 899	0 922	0 937	0 949	0 970	0 983	0 996	1 004	1 012
1 90	0 866	0 897	0 921	0 936	0 948	0 969	0 982	0 996	1 005	1 013
1 95	0 864	0 896	0 920	0 935	0 948	0 969	0 982	0 995	1 005	1 013
2 00	0 861	0 893	0 918	0 933	0 947	0 968	0 982	0 996	1 006	1 014
2 05	0 859	0 891	0 917	0 932	0 946	0 968	0 982	0 996	1 006	1 014
2 10	0 856	0 889	0 916	0 931	0 945	0 967	0 981	0 995	1 007	1 016
2 15	0 854	0 887	0 914	0 930	0 945	0 967	0 981	0 996	1 007	1 016
2 20	0 851	0 886	0 912	0 929	0 944	0 966	0 981	0 995	1 007	1 016
2 25	0 850	0 884	0 911	0 928	0 943	0 966	0 981	0 995	1 007	1 016
2 30	0 848	0 882	0 909	0 927	0 942	0 965	0 980	0 995	1 008	1 017
2 35	0 846	0 881	0 908	0 927	0 942	0 965	0 980	0 995	1 008	1 017
2 40	0 843	0 879	0 907	0 926	0 941	0 964	0 980	0 995	1 008	1 018
2 45	0 842	0 878	0 906	0 926	0 941	0 964	0 980	0 996	1 008	1 018
2 50	0 840	0 876	0 904	0 924	0 941	0 963	0 980	0 995	1 009	1 019
2 55	0 838	0 875	0 903	0 923	0 941	0 963	0 980	0 995	1 009	1 019
2 60	0 837	0 873	0 902	0 922	0 940	0 963	0 980	0 995	1 009	1 020
2 65	0 835	0 872	0 901	0 922	0 940	0 963	0 980	0 996	1 009	1 020
2 70	0 833	0 871	0 900	0 921	0 939	0 962	0 980	0 995	1 010	1 021
2 75	0 832	0 870	0 900	0 921	0 939	0 962	0 980	0 996	1 010	1 021
2 80	0 830	0 869	0 899	0 920	0 938	0 962	0 980	0 996	1 010	1 022
2 85	0 829	0 868	0 898	0 920	0 938	0 962	0 980	0 996	1 010	1 022
2 90	0 828	0 867	0 897	0 919	0 938	0 962	0 980	0 997	1 011	1 023

Table A-3, continued

Pseudo reduced Pressure, P_{pr}	Pseudoreduced Temperature, T_{pr}									
	1 05	1 10	1 15	1 20	1 25	1 30	1 35	1 40	1 45	1 50
2 95	0 401	0 434	0 465	0 532	0 580	0 625	0 670	0 709	0 747	0 778
3 00	0 407	0 440	0 469	0 534	0 581	0 624	0 669	0 707	0 745	0 777
3 05	0 413	0 446	0 454	0 537	0 582	0 624	0 669	0 706	0 744	0 776
3 10	0 420	0 452	0 499	0 540	0 584	0 625	0 668	0 706	0 742	0 775
3 15	0 426	0 457	0 503	0 543	0 586	0 626	0 668	0 704	0 742	0 774
3 20	0 432	0 463	0 507	0 546	0 588	0 626	0 668	0 703	0 741	0 773
3 25	0 438	0 469	0 511	0 548	0 590	0 627	0 668	0 701	0 741	0 773
3 30	0 445	0 476	0 516	0 551	0 592	0 628	0 669	0 702	0 740	0 772
3 35	0 451	0 481	0 520	0 555	0 594	0 629	0 669	0 702	0 740	0 772
3 40	0 458	0 488	0 526	0 559	0 597	0 631	0 670	0 703	0 739	0 771
3 45	0 464	0 494	0 530	0 562	0 599	0 632	0 670	0 703	0 739	0 771
3 50	0 471	0 500	0 536	0 566	0 602	0 633	0 670	0 704	0 739	0 771
3 55	0 477	0 505	0 539	0 569	0 605	0 635	0 672	0 706	0 739	0 771
3 60	0 483	0 511	0 544	0 572	0 608	0 637	0 673	0 706	0 740	0 771
3 66	0 490	0 517	0 548	0 577	0 611	0 639	0 675	0 707	0 740	0 771
3 70	0 497	0 523	0 553	0 582	0 614	0 641	0 677	0 709	0 741	0 772
3 75	0 503	0 529	0 558	0 586	0 617	0 642	0 678	0 709	0 741	0 772
3 80	0 509	0 535	0 563	0 590	0 620	0 644	0 680	0 710	0 742	0 773
3 86	0 516	0 541	0 568	0 594	0 623	0 646	0 681	0 711	0 742	0 773
3 90	0 522	0 547	0 573	0 599	0 627	0 649	0 683	0 713	0 743	0 774
3 95	0 528	0 552	0 577	0 603	0 630	0 651	0 686	0 714	0 744	0 776
4 00	0 534	0 558	0 582	0 608	0 633	0 653	0 687	0 716	0 746	0 776
4 05	0 540	0 564	0 587	0 612	0 636	0 656	0 689	0 717	0 747	0 777
4 10	0 547	0 570	0 592	0 616	0 640	0 659	0 692	0 719	0 749	0 779
4 15	0 553	0 576	0 596	0 620	0 644	0 662	0 695	0 720	0 750	0 780
4 20	0 560	0 581	0 601	0 624	0 648	0 665	0 697	0 722	0 752	0 781
4 25	0 566	0 587	0 606	0 628	0 651	0 668	0 699	0 724	0 753	0 782
4 30	0 572	0 593	0 611	0 632	0 655	0 671	0 701	0 726	0 755	0 784
4 35	0 579	0 598	0 616	0 636	0 658	0 674	0 703	0 728	0 757	0 786
4 40	0 585	0 604	0 621	0 641	0 662	0 678	0 706	0 730	0 759	0 787
4 46	0 592	0 610	0 626	0 646	0 666	0 680	0 709	0 732	0 761	0 788
4 50	0 599	0 616	0 631	0 650	0 670	0 683	0 712	0 734	0 763	0 790
4 55	0 606	0 621	0 636	0 654	0 673	0 687	0 715	0 736	0 765	0 792
4 60	0 612	0 627	0 641	0 659	0 677	0 691	0 718	0 739	0 768	0 794
4 65	0 617	0 633	0 646	0 663	0 681	0 694	0 720	0 741	0 770	0 796
4 70	0 623	0 639	0 651	0 668	0 685	0 698	0 723	0 743	0 772	0 798
4 75	0 630	0 644	0 655	0 672	0 689	0 701	0 726	0 746	0 774	0 800
4 80	0 637	0 650	0 662	0 677	0 693	0 705	0 729	0 749	0 777	0 802
4 85	0 643	0 655	0 667	0 681	0 697	0 708	0 732	0 751	0 779	0 804
4 90	0 650	0 661	0 672	0 686	0 701	0 712	0 736	0 753	0 782	0 806
4 95	0 656	0 666	0 677	0 690	0 705	0 716	0 739	0 756	0 784	0 808
5 00	0 663	0 672	0 683	0 694	0 709	0 720	0 742	0 760	0 787	0 810
5 05	0 669	0 677	0 688	0 698	0 713	0 723	0 745	0 763	0 789	0 812
5 10	0 676	0 683	0 693	0 703	0 717	0 727	0 749	0 766	0 792	0 814
5 15	0 681	0 689	0 698	0 708	0 721	0 731	0 752	0 769	0 796	0 817
5 20	0 688	0 695	0 703	0 713	0 725	0 735	0 755	0 772	0 798	0 820
5 25	0 694	0 700	0 708	0 717	0 729	0 739	0 758	0 776	0 800	0 822
5 30	0 701	0 706	0 713	0 722	0 734	0 743	0 762	0 778	0 803	0 825
5 35	0 707	0 712	0 718	0 726	0 738	0 747	0 765	0 781	0 806	0 827
5 40	0 713	0 718	0 723	0 731	0 742	0 751	0 769	0 785	0 809	0 830
5 45	0 720	0 723	0 728	0 736	0 746	0 755	0 772	0 788	0 812	0 832
5 50	0 727	0 729	0 733	0 740	0 751	0 759	0 776	0 792	0 816	0 835
5 55	0 733	0 734	0 738	0 745	0 755	0 763	0 779	0 795	0 818	0 837
5 60	0 739	0 740	0 744	0 750	0 760	0 768	0 783	0 799	0 821	0 840
5 65	0 746	0 746	0 749	0 755	0 764	0 772	0 787	0 802	0 824	0 843

Table A-3, continued

Pseudo-reduced Pressure, P_{pr}	Pseudoreduced Temperature, T_{pr}									
	1 60	1 70	1 80	1 90	2 00	2 20	2 40	2 60	2 80	3 00
2 95	0 827	0 866	0 897	0 919	0 938	0 962	0 980	0 997	1 011	1 023
3 00	0 825	0 864	0 896	0 918	0 938	0 962	0 981	0 997	1 012	1 024
3 05	0 823	0 863	0 896	0 918	0 938	0 962	0 981	0 997	1 012	1 024
3 10	0 822	0 862	0 896	0 917	0 937	0 962	0 981	0 998	1 013	1 025
3 15	0 822	0 862	0 896	0 917	0 937	0 962	0 981	0 998	1 013	1 026
3 20	0 821	0 861	0 894	0 917	0 937	0 962	0 982	0 998	1 014	1 026
3 25	0 820	0 860	0 894	0 917	0 937	0 962	0 982	0 998	1 014	1 026
3 30	0 819	0 859	0 893	0 916	0 937	0 962	0 982	0 998	1 015	1 027
3 35	0 819	0 859	0 893	0 916	0 937	0 962	0 982	0 998	1 016	1 027
3 40	0 818	0 858	0 892	0 916	0 937	0 963	0 983	1 000	1 016	1 028
3 45	0 818	0 858	0 892	0 916	0 937	0 963	0 983	1 000	1 016	1 029
3 50	0 817	0 858	0 891	0 916	0 937	0 963	0 984	1 000	1 017	1 030
3 55	0 817	0 858	0 891	0 916	0 937	0 963	0 984	1 000	1 017	1 030
3 60	0 816	0 857	0 890	0 916	0 937	0 964	0 985	1 001	1 018	1 031
3 65	0 816	0 857	0 890	0 916	0 937	0 964	0 985	1 001	1 019	1 031
3 70	0 816	0 856	0 890	0 916	0 937	0 965	0 986	1 002	1 019	1 032
3 75	0 816	0 856	0 890	0 916	0 937	0 966	0 986	1 002	1 019	1 032
3 80	0 816	0 856	0 891	0 916	0 937	0 966	0 987	1 003	1 020	1 033
3 85	0 816	0 856	0 891	0 916	0 937	0 966	0 988	1 004	1 021	1 033
3 90	0 817	0 856	0 891	0 917	0 938	0 967	0 989	1 005	1 022	1 034
3 95	0 817	0 856	0 891	0 917	0 938	0 967	0 989	1 006	1 022	1 034
4 00	0 818	0 856	0 892	0 917	0 938	0 968	0 990	1 007	1 023	1 035
4 05	0 818	0 856	0 892	0 917	0 938	0 968	0 991	1 008	1 023	1 035
[illegible]	[illegible]	[illegible]	[illegible]	0 918	0 940	0 969	0 992	1 008	1 024	1 036
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0 970	0 993	1 010	1 026	1 038
4 25	0 823	0 858	0 896	0 918	0 941	0 971	0 994	1 011	1 026	1 037
4 30	0 824	0 861	0 897	0 920	0 942	0 972	0 995	1 012	1 026	1 037
4 35	0 826	0 861	0 897	0 920	0 942	0 973	0 996	1 013	1 027	1 038
4 40	0 826	0 862	0 897	0 921	0 942	0 973	0 997	1 013	1 028	1 038
4 45	0 827	0 862	0 898	0 922	0 943	0 974	0 998	1 014	1 029	1 040
4 50	0 829	0 864	0 900	0 922	0 943	0 976	0 999	1 015	1 029	1 040
4 55	0 830	0 865	0 900	0 923	0 944	0 977	1 000	1 016	1 030	1 041
4 60	0 832	0 866	0 901	0 924	0 945	0 977	1 001	1 017	1 031	1 042
4 65	0 833	0 867	0 902	0 925	0 946	0 978	1 002	1 018	1 032	1 043
4 70	0 835	0 868	0 903	0 926	0 947	0 979	1 003	1 019	1 033	1 043
4 75	0 836	0 869	0 904	0 927	0 948	0 981	1 004	1 020	1 034	1 044
4 80	0 838	0 870	0 905	0 928	0 949	0 982	1 005	1 021	1 035	1 045
4 85	0 840	0 872	0 907	0 929	0 950	0 983	1 007	1 022	1 036	1 046
4 90	0 842	0 873	0 908	0 930	0 951	0 984	1 008	1 023	1 037	1 047
4 95	0 844	0 876	0 910	0 932	0 952	0 985	1 009	1 024	1 038	1 048
5 00	0 846	0 877	0 911	0 933	0 953	0 986	1 010	1 026	1 038	1 048
5 05	0 848	0 879	0 912	0 934	0 954	0 988	1 011	1 027	1 039	1 049
5 10	0 850	0 880	0 914	0 936	0 956	0 989	1 012	1 028	1 040	1 050
5 15	0 851	0 882	0 916	0 937	0 957	0 990	1 013	1 029	1 041	1 051
5 20	0 853	0 884	0 917	0 938	0 958	0 991	1 015	1 030	1 042	1 051
5 25	0 856	0 886	0 919	0 940	0 960	0 992	1 016	1 031	1 043	1 052
5 30	0 858	0 887	0 920	0 941	0 961	0 993	1 017	1 032	1 044	1 052
5 35	0 860	0 889	0 921	0 943	0 963	0 995	1 018	1 033	1 045	1 053
5 40	0 862	0 891	0 923	0 944	0 964	0 996	1 019	1 034	1 046	1 053
5 45	0 864	0 893	0 926	0 946	0 966	0 998	1 021	1 036	1 047	1 056
5 50	0 866	0 896	0 928	0 947	0 967	0 999	1 022	1 036	1 048	1 056
5 55	0 868	0 897	0 928	0 949	0 969	1 000	1 023	1 038	1 049	1 057
5 60	0 870	0 899	0 929	0 950	0 970	1 001	1 024	1 039	1 050	1 058
5 65	0 872	0 900	0 931	0 952	0 972	1 003	1 026	1 040	1 051	1 058
5 70	0 874	0 902	0 933	0 953	0 974	1 004	1 027	1 041	1 052	1 060

Table A-3, continued

Pseudo-reduced Pressure P_{pr}	Pseudoreduced Temperature T_{pr}									
	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
5.70	0.751	0.751	0.754	0.760	0.769	0.777	0.791	0.806	0.827	0.846
5.75	0.757	0.756	0.759	0.764	0.773	0.781	0.795	0.809	0.830	0.848
5.80	0.763	0.762	0.764	0.769	0.778	0.785	0.799	0.813	0.833	0.851
5.85	0.768	0.768	0.770	0.774	0.782	0.789	0.803	0.817	0.836	0.854
5.90	0.775	0.774	0.777	0.779	0.787	0.794	0.807	0.821	0.839	0.857
5.95	0.781	0.779	0.782	0.784	0.792	0.798	0.810	0.824	0.842	0.860
6.00	0.788	0.785	0.787	0.789	0.797	0.803	0.814	0.828	0.845	0.863
6.05	0.794	0.790	0.792	0.795	0.801	0.807	0.818	0.831	0.848	0.866
6.10	0.800	0.796	0.797	0.800	0.805	0.812	0.822	0.835	0.852	0.868
6.15	0.805	0.801	0.802	0.805	0.809	0.816	0.826	0.838	0.856	0.870
6.20	0.811	0.807	0.808	0.810	0.814	0.820	0.830	0.842	0.858	0.873
6.25	0.816	0.812	0.813	0.816	0.818	0.824	0.834	0.845	0.861	0.876
6.30	0.822	0.818	0.818	0.820	0.823	0.828	0.838	0.850	0.864	0.880
6.35	0.828	0.824	0.823	0.825	0.828	0.833	0.843	0.853	0.867	0.883
6.40	0.835	0.830	0.829	0.830	0.833	0.838	0.848	0.857	0.871	0.886
6.45	0.841	0.836	0.834	0.835	0.837	0.842	0.852	0.861	0.874	0.889
6.50	0.848	0.841	0.839	0.840	0.842	0.847	0.856	0.865	0.878	0.892
6.55	0.853	0.846	0.844	0.845	0.846	0.851	0.860	0.868	0.881	0.895
6.60	0.858	0.852	0.850	0.851	0.851	0.856	0.864	0.871	0.884	0.898
6.65	0.864	0.857	0.856	0.856	0.856	0.859	0.868	0.875	0.888	0.900
6.70	0.870	0.863	0.860	0.861	0.861	0.863	0.872	0.880	0.892	0.903
6.75	0.876	0.868	0.865	0.866	0.865	0.867	0.876	0.884	0.895	0.906
6.80	0.881	0.874	0.871	0.872	0.870	0.872	0.880	0.888	0.899	0.910
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7.00	0.903	0.896	0.892	0.890	0.890	0.890	0.896	0.902	0.913	0.923
7.05	0.908	0.901	0.897	0.895	0.894	0.897	0.900	0.906	0.916	0.926
7.10	0.915	0.907	0.902	0.900	0.899	0.899	0.903	0.910	0.920	0.929
7.15	0.921	0.912	0.908	0.905	0.903	0.903	0.907	0.914	0.923	0.932
7.20	0.928	0.918	0.913	0.910	0.908	0.907	0.911	0.918	0.927	0.935
7.25	0.933	0.923	0.918	0.915	0.912	0.910	0.915	0.921	0.930	0.938
7.30	0.938	0.929	0.923	0.920	0.917	0.914	0.919	0.925	0.934	0.942
7.35	0.943	0.934	0.928	0.924	0.921	0.918	0.923	0.928	0.937	0.946
7.40	0.949	0.940	0.933	0.929	0.926	0.923	0.927	0.932	0.941	0.950
7.45	0.954	0.945	0.938	0.934	0.930	0.927	0.931	0.936	0.944	0.953
7.50	0.961	0.951	0.943	0.939	0.935	0.932	0.935	0.940	0.948	0.956
7.55	0.966	0.956	0.948	0.944	0.939	0.936	0.939	0.944	0.951	0.958
7.60	0.972	0.961	0.953	0.948	0.944	0.941	0.943	0.948	0.956	0.962
7.65	0.977	0.966	0.958	0.954	0.949	0.945	0.947	0.952	0.958	0.966
7.70	0.983	0.972	0.963	0.959	0.954	0.950	0.952	0.956	0.962	0.969
7.75	0.989	0.977	0.968	0.963	0.958	0.954	0.956	0.959	0.966	0.972
7.80	0.995	0.983	0.973	0.968	0.962	0.958	0.960	0.963	0.969	0.976
7.85	1.000	0.988	0.978	0.973	0.966	0.963	0.964	0.967	0.973	0.979
7.90	1.005	0.993	0.984	0.978	0.970	0.968	0.968	0.972	0.977	0.982
7.95	1.011	0.999	0.989	0.983	0.974	0.972	0.972	0.976	0.980	0.986
8.00	1.017	1.005	0.995	0.988	0.979	0.977	0.976	0.980	0.984	0.990
8.05	1.022	1.010	1.000	0.993	0.983	0.982	0.980	0.984	0.988	0.994
8.10	1.027	1.016	1.006	0.998	0.987	0.987	0.984	0.988	0.992	0.998
8.15	1.032	1.021	1.011	1.002	0.991	0.991	0.988	0.992	0.996	1.000
8.20	1.038	1.026	1.016	1.007	0.996	0.996	0.992	0.996	1.000	1.003
8.25	1.044	1.031	1.021	1.012	1.000	1.000	0.996	0.999	1.004	1.007
8.30	1.050	1.037	1.026	1.017	1.005	1.004	1.001	1.003	1.008	1.011
8.35	1.055	1.042	1.031	1.021	1.010	1.008	1.005	1.007	1.011	1.014
8.40	1.060	1.048	1.036	1.026	1.015	1.012	1.010	1.012	1.015	1.018

Table A-3, continued

Pseudo-reduced Pressure P_{pr}	Pseudoreduced Temperature T_{pr}									
	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00
5.70	0.977	0.986	0.995	0.996	0.976	1.006	1.028	1.042	1.053	1.060
5.75	0.979	0.987	0.977	0.987	0.977	1.007	1.029	1.043	1.054	1.061
5.80	0.982	0.989	0.979	0.990	0.979	1.008	1.031	1.045	1.056	1.062
5.85	0.984	0.991	0.980	0.991	0.980	1.009	1.032	1.046	1.056	1.063
5.90	0.987	0.993	0.982	0.993	0.982	1.011	1.033	1.048	1.057	1.064
5.95	0.989	0.995	0.984	0.995	0.984	1.012	1.034	1.049	1.058	1.066
6.00	0.992	0.998	0.985	0.997	0.985	1.013	1.036	1.050	1.058	1.066
6.05	0.994	0.000	0.988	0.998	0.987	1.015	1.037	1.051	1.060	1.067
6.10	0.997	0.002	0.990	0.000	0.989	1.017	1.038	1.052	1.061	1.068
6.15	0.999	0.004	0.992	0.001	0.991	1.018	1.039	1.053	1.062	1.069
6.20	1.002	1.007	1.004	1.002	1.002	1.019	1.041	1.055	1.063	1.070
6.25	1.004	1.009	1.006	1.005	1.005	1.020	1.042	1.056	1.064	1.071
6.30	1.007	1.011	1.008	1.007	1.007	1.022	1.043	1.057	1.065	1.072
6.35	1.009	1.013	1.010	1.009	1.008	1.023	1.045	1.058	1.066	1.072
6.40	1.012	1.016	1.012	1.011	1.010	1.025	1.047	1.060	1.067	1.073
6.45	1.014	1.018	1.014	1.013	1.011	1.026	1.048	1.060	1.068	1.074
6.50	1.018	1.021	1.016	1.015	1.013	1.028	1.049	1.062	1.069	1.075
6.55	1.020	1.023	1.018	1.017	1.015	1.029	1.050	1.063	1.070	1.076
6.60	1.023	1.025	1.020	1.019	1.017	1.031	1.052	1.064	1.072	1.077
6.65	1.026	1.027	1.022	1.021	1.020	1.032	1.053	1.065	1.073	1.078
6.70	1.028	1.030	1.024	1.023	1.022	1.034	1.054	1.067	1.074	1.080
6.75	1.030	1.032	1.026	1.025	1.024	1.035	1.056	1.068	1.075	1.081
6.80	1.033	1.034	1.028	1.027	1.026	1.036	1.057	1.069	1.077	1.082
6.85	1.035	1.036	1.030	1.029	1.028	1.038	1.058	1.070	1.078	1.083
6.90	1.037	1.038	1.032	1.031	1.030	1.039	1.059	1.071	1.079	1.084
6.95	1.039	1.040	1.034	1.033	1.032	1.040	1.060	1.072	1.080	1.085
7.00	0.944	0.988	0.988	1.004	1.034	1.044	1.062	1.073	1.081	1.086
7.05	0.947	0.987	0.990	1.006	1.032	1.046	1.063	1.076	1.082	1.087
7.10	0.950	0.970	0.992	1.008	1.024	1.047	1.065	1.077	1.083	1.088
7.15	0.953	0.972	0.994	1.010	1.026	1.048	1.066	1.078	1.084	1.089
7.20	0.956	0.976	0.997	1.012	1.028	1.050	1.067	1.079	1.086	1.091
7.25	0.958	0.977	0.999	1.014	1.029	1.051	1.068	1.080	1.087	1.092
7.30	0.962	0.980	1.001	1.017	1.031	1.053	1.070	1.081	1.088	1.093
7.35	0.966	0.982	1.003	1.019	1.033	1.056	1.071	1.082	1.089	1.094
7.40	0.968	0.986	1.006	1.021	1.036	1.057	1.072	1.084	1.091	1.095
7.45	0.970	0.988	1.007	1.023	1.037	1.058	1.074	1.086	1.092	1.096
7.50	0.973	0.991	1.010	1.025	1.039	1.060	1.076	1.087	1.093	1.098
7.55	0.976	0.993	1.012	1.027	1.041	1.061	1.077	1.088	1.094	1.099
7.60	0.979	0.996	1.015	1.029	1.043	1.063	1.079	1.089	1.096	1.100
7.65	0.981	0.998	1.017	1.031	1.045	1.066	1.080	1.090	1.097	1.101
7.70	0.984	1.001	1.019	1.033	1.047	1.067	1.082	1.092	1.098	1.102
7.75	0.987	1.003	1.021	1.035	1.049	1.068	1.083	1.093	1.099	1.103
7.80	0.990	1.006	1.024	1.038	1.051	1.070	1.084	1.096	1.100	1.104
7.85	0.993	1.008	1.026	1.040	1.053	1.071	1.086	1.096	1.101	1.105
7.90	0.997	1.012	1.029	1.042	1.056	1.073	1.087	1.098	1.103	1.107
7.95	0.999	1.016	1.031	1.044	1.057	1.075	1.088	1.099	1.104	1.108
8.00	1.001	1.018	1.033	1.047	1.059	1.078	1.090	1.100	1.106	1.110
8.05	1.004	1.020	1.036	1.049	1.060	1.079	1.091	1.101	1.107	1.111
8.10	1.008	1.022	1.038	1.051	1.062	1.081	1.093	1.102	1.109	1.112
8.15	1.011	1.025	1.040	1.053	1.064	1.082	1.096	1.103	1.110	1.113
8.20	1.014	1.028	1.043	1.056	1.066	1.084	1.097	1.106	1.111	1.116
8.25	1.017	1.030	1.045	1.057	1.068	1.086	1.099	1.105	1.112	1.116
8.30	1.021	1.033	1.048	1.060	1.070	1.088	1.100	1.108	1.113	1.118
8.35	1.024	1.035	1.050	1.062	1.072	1.090	1.101	1.108	1.115	1.119
8.40	1.027	1.038	1.052	1.064	1.074	1.091	1.102	1.111	1.117	1.120

Table A-3, continued

Pseudo reduced Pressure, P_{pr}	Pseudoreduced Temperature, T_{pr}									
	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
0.65	1.066	1.053	1.041	1.030	1.019	1.016	1.014	1.016	1.018	1.021
0.70	1.070	1.058	1.046	1.035	1.024	1.021	1.019	1.020	1.023	1.025
0.75	1.075	1.063	1.051	1.040	1.029	1.025	1.023	1.024	1.028	1.030
0.80	1.081	1.068	1.056	1.045	1.034	1.030	1.028	1.028	1.030	1.031
0.85	1.086	1.073	1.061	1.049	1.038	1.034	1.032	1.032	1.034	1.036
0.90	1.092	1.078	1.066	1.054	1.044	1.039	1.037	1.036	1.038	1.038
0.95	1.097	1.083	1.070	1.058	1.049	1.043	1.041	1.040	1.041	1.043
1.00	1.102	1.088	1.075	1.063	1.054	1.048	1.045	1.044	1.045	1.047
1.05	1.108	1.094	1.080	1.068	1.058	1.052	1.049	1.048	1.048	1.049
1.10	1.113	1.099	1.085	1.073	1.063	1.056	1.053	1.052	1.052	1.052
1.15	1.118	1.103	1.090	1.077	1.067	1.060	1.057	1.056	1.056	1.056
1.20	1.124	1.108	1.095	1.082	1.072	1.064	1.061	1.060	1.060	1.060
1.25	1.129	1.113	1.100	1.086	1.076	1.068	1.065	1.064	1.064	1.064
1.30	1.135	1.118	1.105	1.091	1.081	1.073	1.069	1.068	1.068	1.068
1.35	1.140	1.123	1.109	1.096	1.085	1.077	1.073	1.071	1.071	1.071
1.40	1.146	1.128	1.114	1.101	1.090	1.082	1.078	1.076	1.076	1.074
1.45	1.151	1.133	1.119	1.105	1.094	1.086	1.082	1.079	1.078	1.077
1.50	1.157	1.138	1.124	1.110	1.099	1.091	1.086	1.083	1.082	1.081
1.55	1.162	1.143	1.129	1.115	1.104	1.095	1.090	1.087	1.086	1.084
1.60	1.167	1.148	1.134	1.120	1.109	1.100	1.095	1.092	1.090	1.088
1.65	1.172	1.153	1.139	1.124	1.113	1.104	1.099	1.096	1.094	1.092
1.70	1.178	1.159	1.144	1.129	1.118	1.109	1.103	1.100	1.098	1.096
1.75	1.183	1.164	1.149	1.134	1.122	1.113	1.107	1.104	1.101	1.098
1.80	1.189	1.169	1.154	1.139	1.127	1.118	1.111	1.108	1.104	1.102
1.85	1.194	1.174	1.158	1.143	1.132	1.122	1.115	1.112	1.108	1.105

0.70	1.203	1.178	1.163	1.148	1.137	1.127	1.120	1.116	1.112	1.108
0.75	1.206	1.184	1.168	1.153	1.141	1.131	1.124	1.120	1.115	1.113
0.80	1.210	1.189	1.173	1.158	1.146	1.136	1.128	1.124	1.119	1.117
0.85	1.215	1.194	1.178	1.162	1.150	1.139	1.132	1.128	1.123	1.120
0.90	1.221	1.200	1.183	1.167	1.155	1.143	1.137	1.132	1.127	1.123
0.95	1.226	1.205	1.187	1.171	1.159	1.147	1.141	1.136	1.130	1.126
1.00	1.231	1.210	1.192	1.176	1.164	1.152	1.145	1.140	1.134	1.130
1.05	1.236	1.216	1.197	1.180	1.168	1.156	1.149	1.144	1.138	1.134
1.10	1.242	1.220	1.202	1.186	1.173	1.160	1.153	1.148	1.142	1.138
1.15	1.247	1.225	1.206	1.190	1.177	1.164	1.157	1.152	1.145	1.141
1.20	1.252	1.230	1.211	1.195	1.181	1.169	1.162	1.156	1.149	1.145
1.25	1.257	1.236	1.216	1.199	1.185	1.174	1.166	1.160	1.153	1.148
1.30	1.263	1.240	1.221	1.204	1.190	1.179	1.170	1.163	1.157	1.152
1.35	1.268	1.246	1.226	1.208	1.194	1.183	1.174	1.167	1.160	1.156
1.40	1.274	1.250	1.231	1.213	1.199	1.188	1.178	1.171	1.164	1.160
1.45	1.279	1.255	1.236	1.218	1.203	1.192	1.182	1.175	1.168	1.164
1.50	1.285	1.260	1.241	1.223	1.208	1.196	1.186	1.179	1.172	1.168
1.55	1.290	1.266	1.246	1.227	1.212	1.200	1.190	1.183	1.176	1.171
1.60	1.296	1.270	1.251	1.232	1.217	1.204	1.195	1.187	1.180	1.174
1.65	1.301	1.276	1.256	1.236	1.221	1.208	1.199	1.191	1.183	1.177
1.70	1.307	1.280	1.261	1.241	1.226	1.213	1.203	1.195	1.187	1.181
1.75	1.312	1.285	1.266	1.246	1.231	1.217	1.207	1.198	1.191	1.185
1.80	1.318	1.291	1.270	1.251	1.236	1.222	1.211	1.202	1.195	1.189
1.85	1.323	1.296	1.276	1.256	1.240	1.226	1.216	1.206	1.198	1.193
1.90	1.329	1.301	1.280	1.260	1.245	1.230	1.219	1.210	1.202	1.197
1.95	1.334	1.306	1.284	1.265	1.249	1.235	1.223	1.214	1.206	1.200
2.00	1.339	1.311	1.289	1.270	1.254	1.240	1.228	1.218	1.210	1.204
2.05	1.344	1.316	1.294	1.275	1.258	1.244	1.232	1.221	1.213	1.208
2.10	1.350	1.321	1.299	1.280	1.263	1.249	1.236	1.226	1.217	1.211
2.15	1.355	1.326	1.303	1.284	1.268	1.253	1.240	1.229	1.221	1.214

Table A-3, continued

Pseudo-reduced Pressure, P_{pr}	Pseudoreduced Temperature, T_{pr}									
	1 60	1 70	1 80	1 90	2 00	2 20	2 40	2 60	2 80	3 00
0 45	1 029	1 041	1 055	1 066	1 076	1 092	1 103	1 112	1 118	1 121
0 50	1 032	1 044	1 058	1 069	1 078	1 094	1 105	1 113	1 119	1 123
0 55	1 035	1 047	1 060	1 071	1 080	1 095	1 107	1 115	1 120	1 124
0 60	1 039	1 050	1 063	1 073	1 082	1 098	1 109	1 117	1 122	1 126
0 65	1 042	1 052	1 065	1 075	1 084	1 099	1 110	1 118	1 123	1 127
0 70	1 046	1 055	1 068	1 078	1 087	1 101	1 112	1 120	1 125	1 129
0 75	1 048	1 058	1 070	1 080	1 089	1 103	1 113	1 121	1 126	1 130
0 80	1 051	1 061	1 073	1 082	1 091	1 105	1 115	1 122	1 127	1 132
0 85	1 055	1 064	1 075	1 084	1 093	1 107	1 116	1 124	1 129	1 133
0 90	1 058	1 067	1 078	1 087	1 095	1 109	1 118	1 126	1 131	1 135
0 95	1 061	1 069	1 080	1 089	1 097	1 111	1 120	1 127	1 132	1 136
1 00	1 064	1 072	1 083	1 092	1 100	1 113	1 122	1 128	1 134	1 138
1 05	1 067	1 076	1 086	1 094	1 102	1 116	1 124	1 130	1 136	1 139
1 10	1 070	1 078	1 088	1 097	1 104	1 117	1 126	1 132	1 137	1 140
1 15	1 074	1 081	1 091	1 099	1 106	1 119	1 128	1 133	1 138	1 141
1 20	1 078	1 084	1 094	1 102	1 108	1 122	1 130	1 135	1 140	1 143
1 25	1 081	1 086	1 096	1 104	1 110	1 124	1 132	1 136	1 141	1 145
1 30	1 084	1 089	1 099	1 106	1 112	1 126	1 134	1 138	1 143	1 147
1 35	1 087	1 092	1 101	1 108	1 114	1 128	1 136	1 140	1 145	1 148
1 40	1 090	1 095	1 104	1 111	1 117	1 130	1 138	1 142	1 147	1 149
1 45	1 093	1 098	1 106	1 113	1 119	1 132	1 140	1 143	1 148	1 150
1 50	1 097	1 102	1 109	1 116	1 122	1 134	1 142	1 145	1 150	1 152
1 55	1 100	1 104	1 111	1 118	1 124	1 136	1 143	1 147	1 151	1 153
1 60	1 103	1 107	1 114	1 121	1 126	1 139	1 145	1 149	1 153	1 156
1 65	1 106	1 110	1 117	1 123	1 128	1 141	1 147	1 150	1 154	1 156

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1 70	1 109	1 113	1 120	1 126	1 131	1 143	1 149	1 152	1 156	1 158
1 75	1 113	1 116	1 122	1 128	1 133	1 146	1 150	1 154	1 157	1 159
1 80	1 117	1 119	1 125	1 131	1 136	1 148	1 152	1 156	1 159	1 161
1 85	1 120	1 122	1 127	1 133	1 138	1 150	1 154	1 157	1 160	1 162
1 90	1 123	1 126	1 130	1 135	1 140	1 152	1 156	1 159	1 162	1 164
1 95	1 126	1 129	1 133	1 138	1 142	1 154	1 158	1 161	1 163	1 166
2 00	1 130	1 132	1 136	1 141	1 144	1 156	1 160	1 163	1 166	1 167
2 05	1 133	1 135	1 139	1 143	1 146	1 158	1 162	1 164	1 166	1 168
2 10	1 137	1 138	1 141	1 145	1 149	1 160	1 164	1 166	1 168	1 170
2 15	1 140	1 141	1 144	1 147	1 151	1 162	1 165	1 167	1 169	1 171
2 20	1 143	1 144	1 147	1 150	1 154	1 164	1 167	1 169	1 171	1 173
2 25	1 146	1 147	1 149	1 152	1 156	1 166	1 169	1 171	1 173	1 175
2 30	1 149	1 150	1 152	1 155	1 159	1 168	1 171	1 173	1 175	1 177
2 35	1 152	1 153	1 155	1 157	1 161	1 170	1 173	1 174	1 176	1 178
2 40	1 156	1 156	1 158	1 160	1 164	1 172	1 175	1 176	1 178	1 180
2 45	1 159	1 159	1 160	1 162	1 166	1 174	1 177	1 177	1 179	1 181
2 50	1 162	1 162	1 162	1 165	1 169	1 176	1 179	1 179	1 181	1 183
2 55	1 166	1 166	1 165	1 168	1 171	1 178	1 181	1 181	1 182	1 184
2 60	1 169	1 168	1 168	1 171	1 174	1 181	1 183	1 183	1 184	1 186
2 65	1 172	1 170	1 171	1 174	1 176	1 183	1 184	1 184	1 185	1 187
2 70	1 176	1 173	1 174	1 177	1 179	1 185	1 186	1 186	1 187	1 188
2 75	1 179	1 176	1 176	1 179	1 182	1 187	1 187	1 188	1 189	1 190
2 80	1 182	1 179	1 179	1 182	1 185	1 189	1 189	1 190	1 191	1 192
2 85	1 185	1 182	1 182	1 185	1 187	1 191	1 191	1 192	1 192	1 193
2 90	1 190	1 186	1 186	1 188	1 190	1 193	1 193	1 194	1 194	1 195
2 95	1 193	1 189	1 189	1 191	1 192	1 195	1 196	1 196	1 196	1 197
3 00	1 196	1 193	1 192	1 194	1 195	1 197	1 197	1 198	1 198	1 199
3 05	1 199	1 196	1 194	1 196	1 197	1 199	1 199	1 199	1 199	1 200
3 10	1 202	1 199	1 196	1 199	1 200	1 201	1 201	1 201	1 201	1 202
3 15	1 205	1 202	1 199	1 201	1 202	1 203	1 203	1 203	1 203	1 203

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Table A-3, continued

Pseudo-reduced Pressure, p_{pr}	Pseudoreduced Temperature, T_{pr}									
	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
11.20	1.360	1.331	1.308	1.289	1.273	1.257	1.245	1.233	1.225	1.218
11.25	1.365	1.336	1.313	1.294	1.277	1.261	1.249	1.237	1.228	1.221
11.30	1.370	1.341	1.318	1.299	1.282	1.265	1.253	1.241	1.232	1.225
11.35	1.375	1.346	1.323	1.303	1.286	1.269	1.257	1.245	1.236	1.228
11.40	1.381	1.351	1.328	1.308	1.291	1.273	1.261	1.249	1.240	1.232
11.45	1.386	1.356	1.333	1.313	1.295	1.277	1.265	1.253	1.243	1.236
11.50	1.391	1.362	1.338	1.318	1.300	1.282	1.269	1.257	1.247	1.240
11.55	1.396	1.367	1.343	1.322	1.304	1.286	1.273	1.260	1.251	1.244
11.60	1.402	1.372	1.348	1.327	1.309	1.291	1.277	1.264	1.256	1.248
11.65	1.407	1.377	1.353	1.331	1.313	1.295	1.281	1.268	1.258	1.251
11.70	1.412	1.382	1.358	1.336	1.317	1.300	1.286	1.272	1.262	1.256
11.75	1.417	1.387	1.363	1.340	1.321	1.305	1.288	1.276	1.265	1.258
11.80	1.423	1.392	1.368	1.345	1.326	1.309	1.294	1.280	1.269	1.262
11.85	1.428	1.397	1.373	1.350	1.330	1.313	1.298	1.284	1.273	1.266
11.90	1.433	1.402	1.378	1.355	1.335	1.318	1.302	1.288	1.277	1.270
11.95	1.438	1.407	1.383	1.360	1.339	1.322	1.306	1.292	1.280	1.274
12.00	1.444	1.413	1.388	1.364	1.344	1.327	1.310	1.296	1.284	1.278
12.05	1.449	1.418	1.393	1.368	1.348	1.331	1.314	1.299	1.288	1.281
12.10	1.454	1.423	1.398	1.373	1.353	1.335	1.318	1.303	1.292	1.285
12.15	1.459	1.428	1.403	1.378	1.357	1.339	1.322	1.307	1.296	1.288
12.20	1.465	1.433	1.408	1.383	1.362	1.344	1.326	1.311	1.300	1.292
12.25	1.470	1.438	1.413	1.388	1.366	1.348	1.330	1.316	1.304	1.295
12.30	1.475	1.443	1.418	1.392	1.371	1.353	1.334	1.319	1.307	1.299
				1.397	1.376	1.357	1.338	1.323	1.311	1.303
							1.343	1.327	1.316	1.307
12.45	1.491	1.458	1.433	1.407	1.384	1.366	1.346	1.330	1.319	1.310
12.50	1.496	1.464	1.438	1.411	1.389	1.370	1.350	1.334	1.323	1.313
12.55	1.501	1.469	1.443	1.416	1.394	1.374	1.354	1.338	1.326	1.317
12.60	1.507	1.474	1.448	1.420	1.399	1.379	1.358	1.342	1.330	1.321
12.65	1.512	1.479	1.453	1.425	1.404	1.383	1.362	1.346	1.334	1.326
12.70	1.517	1.484	1.458	1.430	1.409	1.388	1.367	1.350	1.337	1.329
12.75	1.522	1.489	1.463	1.435	1.413	1.392	1.371	1.354	1.341	1.332
12.80	1.527	1.495	1.468	1.439	1.418	1.397	1.375	1.358	1.345	1.336
12.85	1.532	1.500	1.473	1.444	1.422	1.401	1.379	1.362	1.348	1.339
12.90	1.537	1.505	1.477	1.449	1.427	1.405	1.383	1.365	1.352	1.342
12.95	1.542	1.510	1.482	1.453	1.431	1.409	1.387	1.369	1.356	1.346
13.00	1.548	1.515	1.487	1.458	1.436	1.414	1.391	1.374	1.360	1.350
13.05	1.553	1.520	1.492	1.463	1.440	1.418	1.395	1.378	1.364	1.354
13.10	1.558	1.525	1.497	1.468	1.445	1.422	1.399	1.381	1.367	1.358
13.15	1.563	1.530	1.502	1.473	1.449	1.426	1.403	1.385	1.371	1.361
13.20	1.568	1.535	1.507	1.477	1.453	1.431	1.408	1.389	1.374	1.364
13.25	1.573	1.540	1.512	1.482	1.458	1.435	1.412	1.393	1.378	1.368
13.30	1.578	1.546	1.517	1.486	1.463	1.440	1.416	1.398	1.382	1.372
13.35	1.583	1.551	1.521	1.491	1.467	1.444	1.420	1.401	1.385	1.375
13.40	1.589	1.556	1.526	1.495	1.472	1.449	1.424	1.404	1.389	1.379
13.45	1.594	1.561	1.531	1.500	1.476	1.453	1.428	1.408	1.393	1.382
13.50	1.599	1.566	1.536	1.504	1.481	1.457	1.432	1.412	1.397	1.386
13.55	1.604	1.571	1.541	1.509	1.485	1.461	1.436	1.416	1.400	1.389
13.60	1.609	1.577	1.546	1.514	1.490	1.466	1.440	1.420	1.404	1.393
13.65	1.614	1.582	1.551	1.518	1.494	1.470	1.444	1.424	1.408	1.396
13.70	1.619	1.587	1.556	1.523	1.499	1.475	1.448	1.428	1.412	1.400
13.75	1.624	1.592	1.561	1.527	1.503	1.479	1.452	1.432	1.416	1.404
13.80	1.630	1.597	1.566	1.532	1.508	1.483	1.456	1.436	1.419	1.408
13.85	1.635	1.602	1.571	1.537	1.513	1.487	1.460	1.439	1.423	1.411
13.90	1.640	1.608	1.575	1.542	1.517	1.492	1.465	1.443	1.426	1.414

Table A-3, continued

Pseudo-reduced Pressure, P_{pr}	Pseudoreduced Temperature, T_{pr}									
	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00
11.20	1.210	1.205	1.202	1.204	1.204	1.206	1.206	1.206	1.206	1.206
11.25	1.213	1.208	1.205	1.205	1.205	1.207	1.207	1.207	1.207	1.207
11.30	1.217	1.211	1.208	1.209	1.209	1.209	1.209	1.209	1.209	1.208
11.35	1.220	1.214	1.211	1.211	1.211	1.211	1.211	1.211	1.210	1.210
11.40	1.224	1.217	1.214	1.214	1.214	1.214	1.214	1.213	1.212	1.212
11.45	1.227	1.220	1.217	1.216	1.216	1.216	1.216	1.216	1.214	1.213
11.50	1.231	1.224	1.220	1.219	1.219	1.218	1.218	1.217	1.216	1.216
11.55	1.234	1.227	1.223	1.222	1.221	1.221	1.220	1.219	1.218	1.217
11.60	1.238	1.230	1.226	1.225	1.224	1.223	1.222	1.221	1.220	1.219
11.65	1.241	1.233	1.229	1.227	1.226	1.226	1.223	1.222	1.221	1.220
11.70	1.245	1.236	1.232	1.230	1.229	1.227	1.226	1.224	1.223	1.222
11.75	1.248	1.239	1.235	1.233	1.232	1.229	1.227	1.226	1.225	1.224
11.80	1.252	1.243	1.238	1.236	1.234	1.231	1.229	1.228	1.227	1.226
11.85	1.256	1.246	1.240	1.238	1.236	1.233	1.231	1.229	1.228	1.227
11.90	1.259	1.250	1.243	1.241	1.239	1.236	1.233	1.231	1.230	1.229
11.95	1.262	1.253	1.246	1.244	1.241	1.238	1.235	1.233	1.231	1.230
12.00	1.266	1.256	1.249	1.247	1.244	1.240	1.237	1.235	1.233	1.232
12.05	1.269	1.260	1.252	1.249	1.246	1.242	1.238	1.236	1.235	1.234
12.10	1.272	1.262	1.255	1.251	1.249	1.244	1.240	1.238	1.237	1.236
12.15	1.275	1.265	1.258	1.254	1.251	1.246	1.242	1.240	1.238	1.237
12.20	1.278	1.268	1.261	1.257	1.254	1.248	1.244	1.242	1.240	1.239
12.25	1.283	1.271	1.264	1.260	1.256	1.250	1.246	1.244	1.242	1.241
12.30	1.287	1.274	1.267	1.262	1.259	1.252	1.248	1.246	1.244	1.243
12.35	1.290	1.277	1.270	1.266	1.261	1.254	1.250	1.247	1.246	1.245
12.40	1.293	1.281	1.273	1.268	1.264	1.256	1.252	1.249	1.248	1.247
12.45	1.296	1.284	1.276	1.270	1.266	1.258	1.254	1.252	1.250	1.248
12.50	1.300	1.288	1.278	1.273	1.268	1.261	1.256	1.254	1.252	1.251
12.55	1.303	1.290	1.282	1.276	1.271	1.263	1.258	1.256	1.254	1.253
12.60	1.307	1.293	1.286	1.278	1.273	1.265	1.260	1.258	1.256	1.255
12.65	1.310	1.297	1.288	1.280	1.276	1.267	1.261	1.259	1.258	1.257
12.70	1.314	1.300	1.291	1.283	1.279	1.269	1.263	1.260	1.259	1.258
12.75	1.317	1.303	1.294	1.286	1.281	1.271	1.266	1.261	1.260	1.259
12.80	1.321	1.306	1.297	1.289	1.283	1.273	1.267	1.263	1.261	1.260
12.85	1.324	1.309	1.299	1.291	1.286	1.276	1.269	1.265	1.263	1.261
12.90	1.328	1.312	1.302	1.294	1.288	1.277	1.271	1.267	1.266	1.263
12.95	1.331	1.316	1.305	1.297	1.291	1.279	1.272	1.268	1.266	1.266
13.00	1.335	1.319	1.308	1.300	1.293	1.281	1.274	1.270	1.268	1.267
13.05	1.338	1.323	1.310	1.302	1.295	1.283	1.276	1.271	1.269	1.268
13.10	1.341	1.326	1.313	1.304	1.298	1.286	1.278	1.273	1.271	1.270
13.15	1.345	1.329	1.316	1.307	1.300	1.288	1.280	1.276	1.273	1.271
13.20	1.349	1.331	1.320	1.310	1.303	1.290	1.282	1.277	1.276	1.273
13.25	1.352	1.334	1.322	1.313	1.305	1.292	1.284	1.278	1.276	1.276
13.30	1.356	1.337	1.325	1.316	1.308	1.294	1.286	1.280	1.278	1.277
13.35	1.360	1.340	1.328	1.318	1.310	1.296	1.287	1.281	1.278	1.278
13.40	1.363	1.343	1.331	1.321	1.313	1.298	1.289	1.283	1.281	1.280
13.45	1.366	1.346	1.334	1.323	1.316	1.300	1.291	1.286	1.282	1.281
13.50	1.368	1.349	1.337	1.326	1.317	1.302	1.293	1.287	1.285	1.283
13.55	1.372	1.352	1.340	1.328	1.319	1.304	1.295	1.289	1.287	1.285
13.60	1.376	1.355	1.343	1.331	1.322	1.306	1.297	1.291	1.289	1.287
13.65	1.379	1.358	1.346	1.334	1.324	1.308	1.298	1.292	1.290	1.288
13.70	1.382	1.361	1.349	1.337	1.327	1.310	1.300	1.294	1.292	1.290
13.75	1.386	1.364	1.351	1.339	1.329	1.312	1.301	1.296	1.293	1.291
13.80	1.389	1.368	1.354	1.342	1.332	1.314	1.303	1.298	1.295	1.293
13.85	1.393	1.371	1.357	1.345	1.334	1.316	1.305	1.300	1.297	1.296
13.90	1.397	1.374	1.360	1.348	1.337	1.318	1.307	1.301	1.299	1.297

Table A-3, continued

Pseudo-reduced Pressure, p_{pr}	Pseudoreduced Temperature, T_{pr}									
	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50
13.95	1.645	1.613	1.580	1.549	1.522	1.496	1.469	1.447	1.430	1.417
14.00	1.650	1.618	1.585	1.550	1.526	1.500	1.473	1.451	1.434	1.421
14.05	1.655	1.623	1.590	1.555	1.531	1.504	1.478	1.455	1.437	1.425
14.10	1.661	1.628	1.595	1.560	1.535	1.509	1.482	1.459	1.441	1.429
14.15	1.666	1.633	1.600	1.565	1.539	1.513	1.486	1.463	1.445	1.432
14.20	1.671	1.639	1.605	1.570	1.544	1.518	1.490	1.467	1.449	1.436
14.25	1.676	1.644	1.609	1.575	1.548	1.522	1.494	1.471	1.452	1.439
14.30	1.681	1.649	1.614	1.580	1.553	1.527	1.498	1.475	1.456	1.443
14.35	1.686	1.650	1.619	1.584	1.557	1.531	1.502	1.478	1.460	1.446
14.40	1.692	1.659	1.624	1.589	1.561	1.535	1.506	1.482	1.464	1.450
14.45	1.697	1.664	1.629	1.594	1.566	1.540	1.510	1.486	1.468	1.454
14.50	1.702	1.669	1.634	1.598	1.570	1.544	1.515	1.490	1.472	1.458
14.55	1.707	1.674	1.639	1.603	1.575	1.548	1.520	1.494	1.476	1.461
14.60	1.712	1.679	1.643	1.608	1.580	1.552	1.524	1.498	1.480	1.466
14.65	1.717	1.684	1.648	1.613	1.584	1.556	1.528	1.502	1.484	1.468
14.70	1.722	1.690	1.653	1.617	1.589	1.561	1.532	1.506	1.488	1.472
14.75	1.727	1.695	1.658	1.622	1.594	1.566	1.536	1.509	1.491	1.475
14.80	1.733	1.700	1.663	1.627	1.598	1.570	1.540	1.513	1.495	1.479
14.85	1.738	1.705	1.668	1.632	1.603	1.574	1.544	1.517	1.498	1.483
14.90	1.743	1.710	1.673	1.636	1.607	1.579	1.549	1.521	1.502	1.487
14.95	1.748	1.716	1.678	1.641	1.612	1.583	1.553	1.526	1.506	1.490
15.00	1.753	1.720	1.682	1.645	1.616	1.588	1.558	1.529	1.508	1.493

Pseudo-reduced Pressure, p_{pr}	Pseudoreduced Temperature, T_{pr}									
	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00
13.95	1.399	1.377	1.363	1.350	1.339	1.320	1.309	1.302	1.300	1.298
14.00	1.402	1.380	1.366	1.353	1.341	1.322	1.311	1.304	1.302	1.300
14.05	1.405	1.383	1.369	1.356	1.343	1.324	1.313	1.306	1.303	1.301
14.10	1.409	1.386	1.372	1.358	1.346	1.326	1.316	1.308	1.305	1.303
14.15	1.412	1.389	1.375	1.360	1.348	1.328	1.317	1.309	1.307	1.305
14.20	1.416	1.392	1.378	1.363	1.351	1.330	1.319	1.311	1.309	1.307
14.25	1.419	1.395	1.381	1.366	1.353	1.332	1.320	1.313	1.310	1.309
14.30	1.423	1.398	1.384	1.369	1.356	1.334	1.322	1.316	1.312	1.310
14.35	1.426	1.401	1.387	1.371	1.358	1.336	1.323	1.316	1.313	1.311
14.40	1.430	1.404	1.390	1.374	1.360	1.338	1.325	1.318	1.316	1.313
14.45	1.433	1.407	1.393	1.376	1.362	1.340	1.327	1.320	1.317	1.316
14.50	1.437	1.411	1.396	1.379	1.365	1.342	1.329	1.322	1.319	1.317
14.55	1.440	1.414	1.398	1.382	1.367	1.344	1.331	1.324	1.321	1.318
14.60	1.443	1.417	1.400	1.385	1.370	1.346	1.333	1.326	1.323	1.320
14.65	1.446	1.420	1.403	1.387	1.372	1.348	1.334	1.327	1.324	1.321
14.70	1.450	1.423	1.407	1.390	1.375	1.350	1.336	1.329	1.326	1.323
14.75	1.453	1.426	1.410	1.392	1.377	1.352	1.338	1.330	1.327	1.326
14.80	1.457	1.429	1.413	1.395	1.380	1.354	1.340	1.332	1.329	1.327
14.85	1.460	1.432	1.416	1.398	1.382	1.356	1.341	1.334	1.331	1.328
14.90	1.463	1.436	1.419	1.401	1.385	1.358	1.343	1.336	1.333	1.330
14.95	1.466	1.439	1.421	1.403	1.387	1.360	1.345	1.338	1.334	1.331
15.00	1.470	1.442	1.424	1.406	1.390	1.362	1.347	1.340	1.336	1.333